SOLE INVENTOR

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Hugo Reyes

APPLICATION FOR
UNITED STATES LETTERS PATENT

SPECIFICATION

TO ALL WHOM IT MAY CONCERN:

Be it known that I, David L. Fosnaugh

a citizen of U. S. A. , residing at Rural Route 1, Box 43, Geneva, Indiana 46740

have invented a new and useful DIE-SHAPING APPARATUS AND PROCESS AND PRODUCT FORMED THEREBY

of which the following is a specification.

Field and Background of the Invention

This invention relates to a process for die punching (stamping) a strip of material such as metal, to a machine for performing the process, and to a product produced by the process. While the process and apparatus described and claimed herein have utility in other fields, the specific example described and claimed herein relates to the production of steel laminations for an electromotive device such as a motor.

The conventional manner of producing laminations is by feeding a long strip of lamination steel through a progressive die. The die has a series of stations and at each station a cut is made in the steel strip, thereby progressing from strip material to finished laminations.

In one process, a strip of straight slit steel is fed into a progressive die which progressively shapes the straight strip into finished laminations. In another process, a wide sheet of metal is cut by a scroll die into a plurality of scroll or zigzag strips, each scroll strip including a series of connected precut sections or discs. Each disc is then shaped by a progressive die into a finished lamination. Further, the discs have pilot holes in them, and each station of the progressive die has pilot pins which engage the pilot holes of the discs for the purpose of orienting the discs properly in the die stations during the punching operations.

There has been a problem with the foregoing prior art procedure which has resulted in a substantial downtime and loss of lamination steel. The problem arises because the between-center spacing between the successive die stations of the

progressive die is fixed but the between-center spacing, or distance, between lamination discs may vary. As a specific example, a progressive die may have a feed length of 5.787"; a spacing of 5.787" ± .0002" between stations one and two; and, because the tolerance is nonaccumulative, a spacing of 17.361" ± .0002" between stations one and four. The center-to-center distance between lamination discs, on the other hand, are variable and the variations are accumulative.

An attempt to solve the foregoing problem has been to make the between-center spacing of successive lamination discs slightly longer than the theoretical feed length. For example, the between-center dimension between the discs has been made up to .0020" longer than the feed length. This extra length can cause the metal strip to bow or buckle as it moves through the die; on the other hand, if the between-center spacing of the discs is not long enough, the discs cannot be fed through the die because the pilot pins of the dies cannot match the pilot holes of the discs. The result has been a disruption of the punching operation and a loss of strip metal.

It is a general object of this invention to provide improved process and apparatus for avoiding the aforementioned problems.

Summary of the Invention

Apparatus in accordance with this invention comprises die means for shaping a consecutive series of discs from a strip of relatively stiff material, said die means comprising a slot cutting station, said slot cutting station including cutting means for forming at least one laterally extending slot

between adjacent discs while leaving at least one narrow deformable bridge connecting said adjacent discs.

Apparatus in accordance with this invention further comprises a strip of relatively stiff material including a series of consecutive discs formed along the length thereof, at least two adjacent discs having at least one laterally extending slot therebetween and at least one narrow deformable bridge connecting said adjacent discs.

A process in accordance with this invention is for die punching a series of shaped discs from a strip of relatively stiff material, said process comprising the steps of cutting at least one slot through said strip between each pair of adjacent sections and forming at least one narrow deformable bridge connecting each pair of adjacent discs, shaping said discs between said bridges, and severing said bridges.

Brief Description of the Drawings

The invention will be better understood from the following detailed description taken in conjunction with the accompanying figures of the drawings, wherein:

Fig. 1 illustrates a prior art apparatus and method for die forming metal laminations;

Fig. 2 illustrates apparatus and method for die forming metal laminations in accordance with this invention;

Fig. 3 is a schematic illustration of dies in accordance with this invention;

Fig. 4 is an enlarged view of fragments of laminations and illustrates this invention;

Fig. 5 is a view similar to Fig. 4; and

Figs. 6 and 7 illustrate alternative embodiments of the invention.

Detailed Description

Fig. 1 illustrates a prior art process for producing laminations for an electromotive machine such as an electric motor. The laminations are punched from a strip 10 of lamination steel which is fed through a conventional progressive die (not illustrated in Fig. 1). The progressive die includes a ins a' plurality of punching stations A through ~~I~~ a', and at each station a portion of the strip is removed to produce a finished rotor lamination disc at station D and a finished stator lamination disc at the final station I. A plurality of such discs are assembled in a stack to form stator and rotor cores.

The strip 10 (Fig. 1), in the received form which is fed into the die at station A, includes a series of sequential G discs or sections, and in this example, discs 10a to 10f ~~10e~~, 10h and 10i are illustrated and associated, respectively, with the C die stations A through F ~~E~~, H and I. In the received form, each disc has four angled outer sides 11 to 14 (see disc 10a), two connecting sides 15 and 16, and a centrally located pilot hole 18.

At station A, the die includes a pilot pin 19 which extends into the pilot hole 18 and centers the disc 10a in this die station. This station also includes four punches 21 which form four round pilot holes 22. At each of the subsequent stations, four pilot pins 23 extend into the holes 22 in order to orient the discs at the stations.

At die station C, a banding slot 26 and two trim slots 27 are formed along the connecting sides of the two discs 10c and 10d. As shown by the enlargement of the slot 26, the ends 28 of the slot are angled; the ends of the slots 27 are semicircular. At station D, the rotor lamination 33 is removed from the strip.

At station E, the die includes punches which trim the outer sides of the disc 10e removing fragments 31 and a thin ring of material 35 is removed from the center of disc 10e to assure ID/OD concentricity and provide for rotor OD to stator ID clearance (air gap). It should be noted that the outer ends of the slots 27 are cut away so that the discs are thereafter attached by two relatively wide connecting sections 32 at the ends of the banding slot 26.

At the subsequent stations, the stator winding slots 34 are cut. At the final station I, a cut is formed through the connecting side along the center of the connecting sections 32 and the banding slot 26, thereby severing the finished forwardmost disc from the strip 10. The angled sides of the slot 26 result in a dovetail-shape opening which may be used to receive a banding strip that secures a stack of laminations together, in a conventional manner.

The die stations are at fixed distances apart and the tolerances are nonaccumulative, as previously explained. On the other hand, the center-to-center distances between the discs making up the strip 10 are not uniform. Consequently, the variations in the disc distances may result in a situation where the pilot pins cannot enter the pilot holes 22, resulting

in disruption of the punching operation and loss of lamination metal.

Figs. 2 and 3 illustrate apparatus in accordance with this invention, which avoids the foregoing problem. In this specific example of the invention, a strip 40 having the same initial shape as the strip 10 shown in Fig. 1 is fed into a progressive punch and die assembly 41 shown schematically in Fig. 3. Again the progressive die set 41 may include nine stations and only stations A, B, C, H and I are illustrated in Fig. 3, and lamination discs 40a, 40b, 40c ~~40e~~, 40h and 40i are illustrated in Fig. 2.

The strip 40 is fed into the progressive die with each disc having the initial configuration illustrated by the disc at the far left in Fig. 2. It includes a centrally located pilot hole 42, four angled sides 43, and a connecting side 44 which is joined with the next adjacent disc. This initial configuration is referred to in the trade as a scroll or zigzag shape, and it is cut from a wide sheet of lamination steel by a scroll die.

The progressive die set 41 (Fig. 3) includes an upper punching assembly 46 and a lower die assembly 47. Except for the feature described hereinafter as the invention, the die may otherwise have a conventional design. In addition to the two parts 46 and 47, the die may also include a stripper (not illustrated) between the strip 40 and the punch assembly.

At station A, the punch assembly 46 includes a pilot 26
pin 51 which extends into the pilot hole 42 of the disc 40a. In addition, four straddle pilots 52 (Fig. 2) engage the sides

43 of the disc 40a, the pilots 51 and 52 serving to locate the disc 40a properly. The punch assembly includes four punches 53 (Fig. 3) which punch four pilot holes 54 in the disc 40a. In addition, slot piercing punches 56 pierce a series of slots 57 through the strip 40, the slots extending laterally across the width of the strip at the connecting side 44. The slots 57 leave a plurality (in this specific example, there are four) of narrow width bridges 58 to 61 between the discs 40 and 40a. The bridges 58 to 61 preferably have an angled or chevron shape as illustrated in Fig. 2, but this is not necessary because they could instead be arcuate, straight longitudinal, etc., as illustrated in Figs. 6 and 7. As will be described in connection with Figs. 4 and 5, the bridges 58 to 61 are sufficiently thin and narrow (in the lateral dimension) to be deformable, and the lateral dimension needed to permit such deformation will depend on the thickness of the strip and the type of metal. As a specific example, for motor lamination steel having a thickness of .025 ± .003 inch, each bridge has a lateral width in the range between .050 and .070 inch, a lateral width of .060 inch being preferred. This example is for standard material known as cold rolled semi-processed motor lamination steel.

It should be apparent that strips of other thicknesses, materials and stiffness should have other bridge dimensions. The bridges must be wide enough to hold adjacent discs together during the punching operation but sufficiently narrow that they may be deformed as will be described. Aside from the narrow bridges, the strips are otherwise stiff and not materially deformable to enable them to accommodate a misalignment of the pilots.

Following the punching of the pilot holes 54 and the slots 57, further punching operations are performed at the subsequent stations. At each station, pilot pins 62 extend into the pilot holes 54 in order to orient the discs. As examples of further punching operations, at station B a large center hole 66 is formed by a punch 67, at station C ~~E~~ segments 67 are trimmed from the outer sides of the disc 40C, at station H, a number of winding slots 68 are formed, and at station I the forwardmost lamination is severed from the strip by making a lateral cut (using a punch 69 in Fig. 3) through the centers of the bridges 59 and 60. a^2

ins. a^2

In the example illustrated the two endmost bridges 58 and 61 are relatively close to the sides 43. When the segments 67 are punched out, the cut along the dashed lines 71 extends to the slots 57 and thus removes the bridges 58 and 61, leaving only the two center bridges to connect adjacent discs.

The chevron shape of the two bridges 59 and 60 result in a dove-tail shape slot 72 (Fig. 2) at the sides of a stack of the laminations, which may receive a banding strip as previously mentioned in connection with the opening 26 shown in Fig. 1. The punches 56 instead may be shaped to produce longer slots 57 and only one deformable bridge, or more than two narrow deformable bridges, for example.

As previously mentioned, a progressive die assembly of the type used to cut the strips 10 and 40 includes a series of successive stations. The center-to-center distances between the stations is fixed, and the tolerances are non accumulative. In the example previously given, the spacing between the

first and second stations is 5.787" ± .0002", and the spacing between the first and fourth stations is 17.361" ± .0002". The center-to-center distances between the discs are variable, however, and the variations may prevent the pins 62 from aligning with and entering the pilot holes 54. This problem has resulted in disruption of the stamping process and considerable loss of lamination steel.

This problem is avoided in accordance with this invention by making the bridges 58 to 61 sufficiently narrow (taking into consideration the type, stiffness and thickness of the strip material) that the bridges are capable of deforming to make up for the differences in the spacing. With reference to Fig. 5, if the center-to-center distance between two adjacent discs 40b and 40c of the strip 40 is less than the center-to-center distance between two adjacent stations B and C of the die 41, the bridges stretch (since they are deformable) to the dashed line positions 76, thereby increasing the separation between the discs 40b and 40c and the center-to-center distance between them. ins. D' The amount of the stretch is sufficient to enable the pilot pins 62 to enter the pilot holes 54 and orient the discs at the adjacent stations. The outer ends of the pilot pins 62 may be conical to enable them to enter the pilot holes and then deform the bridges as the pins fully enter the holes.

In the event the center-to-center distance between the adjacent two discs is greater than the center-to-center distance between the adjacent two stations, the bridges deform to decrease the distance between the two discs. As shown in

Fig. 4, the deformation may take the form of an upward (or downward) bulge or buckle 77 of the bridges, or the bridge may deform laterally to sharpen the angle of the chevron-shaped bridges. In the latter situation, the bridges may deform to the dashed line, positions 78 in Fig. 5. In an alternative construction where the bridges extend straight lengthwise between the discs (see Fig. 7), the bridges would bulge upwardly or downwardly as shown in Fig. 4. Where the bridges are arcuate (see Fig. 6) or chevron shaped (Fig. 5), the deformation may be a combination of the two forms shown in Figs. 4 and 5.

ins. a3

While the prior art strip included sections 32 between adjacent discs, the connecting sections 32 are too wide and stiff to permit their deformation as is the case with the narrow deformable bridges in accordance with this invention. As an example, the connecting sections of the prior art have been approximately .315 inch in lateral width.

The discs or sections of the strip may have shapes other than that shown in Figs. 1 and 2. Figs. 6 and 7 respectively show examples where the discs have square and round shapes. Fig. 6 further illustrates discs connected by two deformable bridges 81 which have arcuate shapes. Fig. 7 illustrates round discs connected by a single deformable bridge 82 and in this example the bridge 82 is straight longitudinal.

The discs shown in Figs. 6 and 7 may also have pilot means cut into them for orientation at the die stations, or the die stations may be provided with straddle pilots such as the pilots 52.

While the slots forming the deformable bridges have been described as being cut at an initial station of a progressive die, it will be apparent that such slots could be cut by a separate die prior to being introduced into the progressive die. For example, these slots could be cut by the scroll die which cuts the strip 40 from the wide metal band, or a separate die may be provided for cutting such slots and pilot holes in the discs.